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ABSTRACT

This handbook introduces teachers and students to the "design conversation," a classroom discussion technique with some variations that involve writing or group work. The design conversation helps students understand topics in the subject matters more deeply and explore them analytically and imaginatively. It is a critical and creative thinking skill for in-depth understanding that can be applied across the curriculum and with students of any age, from kindergarten through college. The handbook outlines the general idea of knowledge as design, the overall classroom approach, and the design conversation. Details follow about how to put knowledge as design to work, "tricks of the trade" about selecting good topics for design conversations, drawing answers from students, keeping activities from running too long, and related matters. The handbook also offers variations on the basic design conversation. The variations keep discussions lively and make knowledge as design more flexible. Concrete resources to support teaching include lesson plans and worksheets to photocopy, topic lists by subject matter, and a reading resource list. (BT)

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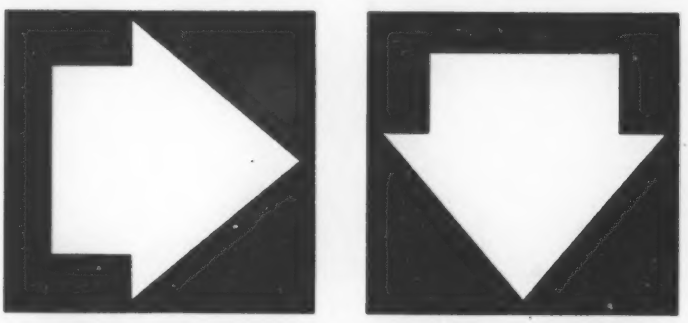
A Handbook for Critical and Creative Discussion across the Curriculum



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Knowledge as Design

A Handbook for Critical and Creative Discussion across the Curriculum

DAVID N. PERKINS

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About the Author

DAVID N. PERKINS holds a Ph.D. in mathematics and artificial intelligence from the Massachusetts Institute of Technology. Since 1971, Dr. Perkins has served at the Harvard Graduate School of Education as co-director of Project Zero. The project, initially concerned with the psychology and philosophy of education in the arts, later broadened to encompass cognitive development and cognitive skills in both the humanities and sciences.

Conducting long-term programs of research and development in the areas of teaching and learning for understanding, creativity, problem solving, and reasoning, Dr. Perkins has authored numerous books and programs in the education field and has given many workshops and presentations regarding thinking and its teaching in the United States and throughout the world.

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The *Knowledge as Design Handbook* and the companion videotape are based on the book *Knowledge as Design* (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1986). My colleague Carolee Matsumoto, at the time Assistant Superintendent of the Concord, Massachusetts, Public Schools, suggested and encouraged the project. The videotape was produced and directed by David Whittier with the collaboration of teachers Bob Lamaire, Lorita Brockington, and Carl Torrice, and the administration of the Concord, Massachusetts, Public Schools. The videotape was planned and the handbook written at the Cognitive Skills Group of Harvard Project Zero, Harvard Graduate School of Education. I thank Diane Downs, administrative coordinator of the Cognitive Skills group, for arranging many details of the handbook and videotaping and for participating in the videotaping process. I am grateful to my longtime colleague Shari Tishman for her suggestions on a first draft of the hand book and to my editor at Critical Thinking Press & Software, Linda Borla, who made valuable contributions in streamlining the manuscript. Finally, the ideas embodied in these materials reflect many years of theoretical and practical work concerning the teachings of thinking and teaching for understanding. Key supporters in these lines of inquiry have been the Spencer Foundation, the John D. and Catherine T. MacArthur Foundation, and the Pew Charitable Trusts.

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Introduction

Welcome to knowledge as design. This handbook and the accompanying videotape provide a comfortable and interesting way to get familiar with knowledge as design and put it to work in your classroom for the benefit of your students and you.

This handbook introduces you to the *design conversation*, a classroom discussion technique with some variations that involve writing or group work. The design conversation helps your students understand topics in the subject matters more deeply. It is a way of thinking about topics and exploring them analytically and imaginatively. It is a kind of critical and creative thinking skill for in-depth understanding that can be applied across the curriculum and with students of any age, from kindergarten through college. Even young students prove good contributors to a design conversation if the language is kept simple, and older students often participate in remarkably insightful ways.

Based on the theory outlined in the book *Knowledge as Design*, this handbook and videotape aim to help you use knowledge as design in an efficient and engaging way. Both this handbook and the videotape provide many examples of knowledge as design at work. This handbook deals with the techniques and discusses how to find topics that play well. The videotape shows teachers conducting class discussions using knowledge as design.

You may find yourself with this handbook but not the videotape since the handbook can be purchased separately. Obviously, it is helpful to have access to the tape. However, the handbook has been designed to work well independently of both the original book and the videotape.

The Handbook

This handbook begins by outlining the general idea of knowledge as design—the overall classroom approach and the design conversation. Then come details about how to put knowledge as design to work—tricks of the trade about selecting good topics for design conversations, drawing answers from students, keeping activities from running too long, and related matters.

This handbook also offers variations on the basic design conversation. The variations help to keep discussions lively and make knowledge as design more flexible. Concrete resources to support your teaching include lesson plans and worksheets to photocopy, topic lists by subject matter, and a reading source list.

The Videotape

The videotape shows knowledge as design in action. It offers a very general introduction to the basics of knowledge as design, and you see teachers using knowledge as design in their classrooms to guide their students in exploring three topics: advertising, puberty, and the brain. You get a sense of how knowledge as design plays in real classroom contexts and an affirmation that knowledge as design applies to very different topics. You also get a feel for the open-ended questioning style of knowledge as design and tips about classroom conduct, including blackboard technique and student-centered teaching. Most importantly, the videotape provides reassurance that students are responsive to knowledge as design and affirmation that students do reach significant insights.

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How to Get Started

There are many ways to get started on a new way of teaching, and you are encouraged to adopt any approach that makes sense to you. You may want to read through this handbook, watch the videotape (if you have it), and put knowledge as design to work on a regular basis in your classroom right away.

Others may find it more comfortable to ease into the process on a weekly basis. For those who find it useful to have a path to follow, here is a straightforward 6-week plan that gradually puts knowledge as design into motion.

Step 1. Read Chapter 1 (watch the videotape, if you have it). Then choose a couple of topics from your upcoming teaching that clearly lend themselves to design conversations and lead those conversations in your classroom.

Step 2. Read Chapter 2 and think more expansively about opportunities for design conversations within the subject matters you teach. Try three design conversations in the course of the week.

Step 3. Use this week to refine your technique with design conversations. Read Chapter 3 (view the videotape again, if you have it). Choose the tricks of the trade that seem most helpful, and try to put them into action in three design conversations in the course of the week.

Step 4. Read Chapter 4 and use the information as a guide to explore more challenging topics in your content areas. Lead three design conversations.

Step 5. Read Chapter 5 and choose some variations of the basic design conversation to explore. Plan and carry out three design-related activities—conversations, homework assignments, hands-on activities, or whatever you choose.

Step 6. You have now worked through a number of techniques. Try to make design conversations and variations of them a regular part of your teaching with three or more activities per week. Look through Chapter 6, take stock of the references, and pursue any further reading you think might be helpful. In particular, the book *Knowledge as Design* on which this handbook and videotape are based has many examples of knowledge as design across a number of content areas.

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Chapter 1

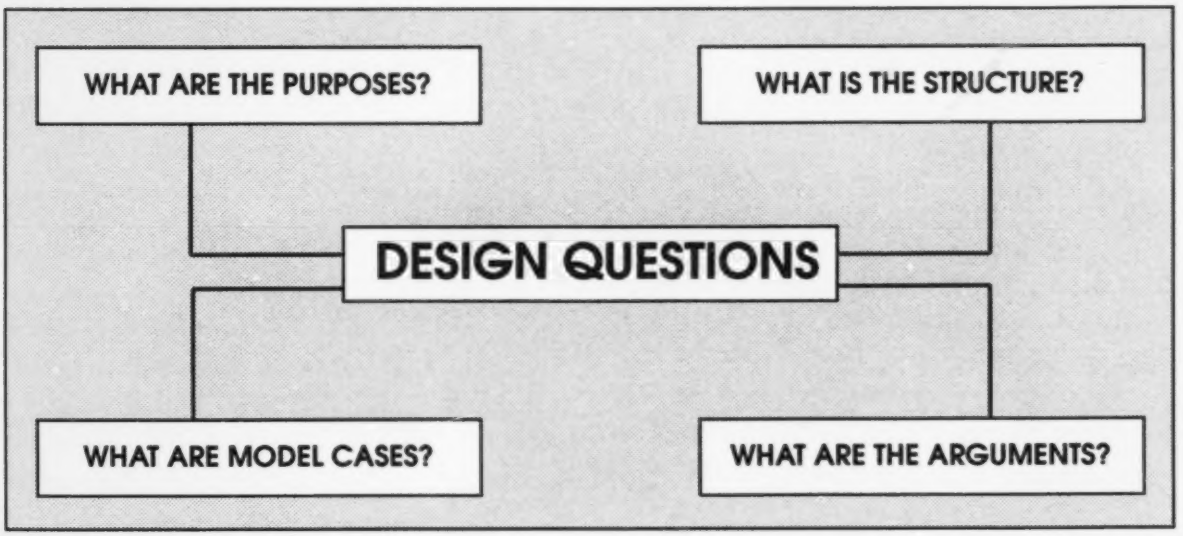
Knowledge as Design: The Basics

Knowledge as design is a teaching method that reflects a very basic principle confirmed over and over again by contemporary cognitive psychology: *Learning is a consequence of thinking.* When students think about what they are learning in a creative and critical way, they understand it better. They even remember it better.

The topics you approach through knowledge as design can be entirely conventional—rules of grammar or forms of government—or the topics can be unconventional—the role of cosmetics in society or the risks of recombinant DNA research. Whether conventional or unconventional, the goal is the same: a genuine understanding that goes beyond just memorizing some facts and figures.

its purpose or function? It provides measurement in a unified way with units easily convertible into one another by multiples of ten. Another purpose is to establish a worldwide standard to facilitate science and commerce.

What form does the metric system have that helps it to fulfill these functions? Well, the metric system includes measures both of distance (centimeters, meters, kilometers) and mass (grams, kilograms, metric tons). The distance measures in turn yield volumetric measures—cubic centimeters or cubic decimeters. The choice of units provides for easy conversion from one unit to another. We could discuss many other features of the metric system, for instance, how the values of the standard units are fixed. Indeed, we understand the metric system better by pondering its functions, its form, and how form fits functions.



The basic idea of knowledge as design is very straightforward: *form fits function.* Essentially, design is structure adapted to purpose. We can think about the *purposes* of items or ideas, that is, their functions. And we can also ponder how the *structures*, the features, the forms, suit those purposes.

By way of example, let us brainstorm on a case in point. For instance, consider a standard school topic, the metric system. What is

As this example shows, knowledge as design is based on a very simple idea. You just ask how form fits function, how features connect to purposes. But the results are not so simple. By asking questions like these, you can lead students to dig deeper inside topics, to discover how things fit together, to explore

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the *why* of things—in short, to think critically and creatively about what they are learning.

The Four Design Questions

The basic *design conversation* explores the form-fits-function character of a topic—how structure (form) fits purposes (functions)—by asking *four design questions:*

1. What are the *purposes*? What is it for?
2. What is the *structure*? What does it look like; how is it made?
3. What are *model cases*? What are some specific examples?
4. What are the *arguments*?
   Explain how the structure fits the purposes: Why these particular features; how do they help?
   Evaluate pros and cons: How well does the item or idea meet its purposes?

To see how the design questions work, let us apply them to the metric system (see chart below). Although many more purposes, model cases, elements of structure, and arguments could be listed, the example below shows how the design questions work.

Of course, this is a simple example, but the four design questions actually offer a great deal of flexibility. You do not have to use the design questions in a specific order. You might want to start with model cases, for instance, to provide examples first. Nor do you have to use all four questions although the four taken together and pursued vigorously ensure a quite thorough exploration.

Some teachers use an expanded vocabulary—features instead of or in addition to structure, for example. Whether you use the four key terms or a broader set, be consistent. Keep reusing your chosen vocabulary so that students get used to it. Here is an expanded design vocabulary.

- Purposes—objectives, functions, goals, aims
- Structure—organization, properties, materials, features, parts
- Model Cases—cases in point, analogies, examples, images
- Arguments—explanations, evaluation, reasons, evidence

Design Conversations

How do you prepare and carry out a design conversation? The basic *design conversation strategy* involves three broad phases—*choice*, *conversation*, and *closure*. First, choose an appropriate topic. Next, hold a conversation with your students based on the four design questions. Finally, round out the conversation with closure, some broad conclusions that consolidate the students' insights.

The first and last phases, choice and closure, typically only take a few minutes. The

TOPIC: METRIC SYSTEM

PURPOSES	MODEL CASES	STRUCTURE	ARGUMENTS
• Standard measurement • Easy conversion between units	• millimeters centimeters meters kilometers • grams kilograms metric ton	• Based on meters and grams • Systematic prefixes name other units: kilo deca centi milli	• Provision for deriving other units • Simplifies nomenclature • Units chosen to match everyday needs

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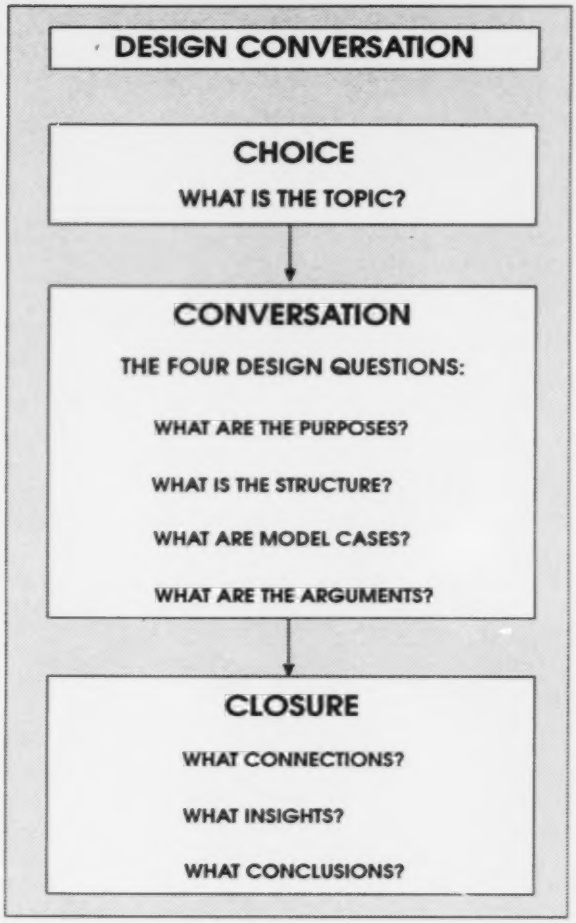

middle phase, conversation, can take anywhere from ten minutes to an entire class period or more, depending on how much time you want to invest in the topic.

Choice: Picking a Topic

Before holding a design conversation, you need to choose a good topic. In a way, the real problem in planning design conversations is the sheer number of topic choices. You can choose any thing or idea that has purposes—punctuation, forms of government, the ending of a play, treaties. Virtually any subject you are teaching will have many ideas within it that make good topics for design conversations. Here are some general guidelines:

- Choose a topic that you think is worthwhile for your students to explore and understand more deeply.
- For a start, choose topics that are somewhat concrete; for instance, bones rather than anatomy; zero rather than number systems (a later chapter discusses how to handle abstract topics).
- Imagine how your students will respond to the design questions. Do your students know enough from their studies and everyday experience to explore them? If not, simplify the topic or assign reading as preparation.

Normally, you would choose a topic before class as you prepare your lesson plan although you might occasionally choose a topic on the spur of the moment.

To test a potential topic, just jot down one or two purposes, model cases, aspects of structure, and explanations or pros and cons. You may want to use a copy of the design conversation lesson plan worksheet (see page 34). If the topic does not play well for you, it is not likely to play well for your students. Modify the topic or choose another one.

If the topic works well for you, what about your students? Imagine yourself in your classroom setting, conducting a design conversation using the topic. Imagine asking the design questions and the students trying to answer.

What happens in this "mental movie?" Do the students respond readily? Are they confused? Are they bored? Are they excited? The mental movie should give clues about what problems are likely to arise, if any. Then you can nudge the topic in a direction to avoid those problems. (For more tips, see Chapter 4, pages 23–26).

When dealing with abstract topics, you may want to give the abstraction a more specific context—scientific theories of the origin of stars rather than just scientific theories—or choose a specific case—a particular scientific theory, such as Newton's Law F = ma (see lesson plan, page 21).

Alternatively, you could choose two or three specific cases, conduct a design conver-

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sation on each, and then engage your students in a compare and contrast discussion to bring out the generalities.

Conversation: Leading a Knowledge as Design Discussion

Once you have chosen a topic, conduct a design conversation based on the four design questions. Ask the four design questions in whatever order seems appropriate. Articulate the questions clearly and offer further explanation, if needed. Remember, although you need not use the official vocabulary, do be consistent. You want students to get familiar with a set of key terms and become comfortable with the kinds of thinking they ask for.

As you take up each question, draw a number of answers from your students. Proceed in an open-spirited, brainstorming style. Give hints or sample answers if needed.

Sometimes a student's response may seem to answer two of the design questions at the same time—both the purpose and structure questions, for instance. Do not worry about such mixed responses; accept them for either design question or both. The four questions are meant to generate thoughtful exploration, not to define absolutely separate categories.

Keep track of the student's answers on the blackboard. Write down most answers even if you think some are not entirely appropriate. If you feel you have to signal an incorrect answer, try to do so in a way that honors the student's participation. Do not criticize answers; rather, you can say, "That's an interesting idea. Some may see it another way, and if so, we can talk about it later." If it is an error of fact that you cannot let pass, say, "I'm not sure that's true, but let's put it up with a question mark and think about it later."

Be aware that criticism from the teacher will inhibit students' readiness to respond during this answer-generating phase. Obviously, there are many times when you need to correct students' answers assiduously, but not during a design conversation. Matters of correctness can be sorted out later.

Teachers who use brainstorming techniques in their classroom will recognize that a design conversation involves extensive brainstorming—and more. The purpose, model cases, structure, and arguments questions are carefully chosen to give the brainstorming a direction that helps to build students' understanding. The closure step, described below, ensures that the results of the brainstorming get consolidated into some broad conclusions.

Closure: Wrapping Up a Design Conversation

Round up the discussion by asking students what they have learned: What insights did they arrive at? What connections did they make that seemed especially worthwhile? What conclusions can they draw? Your blackboard notes will help you and your students to look back and see the big picture.

If you prefer, you can summarize the highlights. It is usually better for students to discover their own conclusions, but you may want to make a particularly important point, or time constraints may not allow a more extended closure.

Sample Design Conversation

What do design conversations actually sound like? If you have the videotape, it will show you some examples. In addition, here is a sample in print. Suppose a teacher chooses the topic of voting, something commonly discussed as part of the social studies curriculum. The teacher decides to check out the topic using the design conversation lesson plan worksheet, a planning resource. (See worksheet blank, page 34; voting lesson plan, page 6.) The results are reassuring; it looks as though the topic will play well. The teacher chooses to begin the design conversation by asking for model cases.

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Sample Design Conversation—Voting

TEACHER: Let's focus on voting. We all know that voting is an important tool for making social decisions. But what model cases of voting have you actually encountered? When does voting make an appearance?

STUDENTS: Voting for president. Voting for what field trip to take. Voting what game to play.

TEACHER: Let's look at these voting situations. Let's ask ourselves what voting does for us? That is, what are the purposes or functions of voting? Think about it for a few seconds, and then we will list as many purposes as we can on the board.

STUDENTS: People feel good because they have a say. Before the vote, people get to argue what they think is best, so maybe a better decision results. Even if a few people are not satisfied with the decision afterward, most people are, at least when it's a choice between two things.

TEACHER (after collecting more purposes): That's a nice list of purposes. Now let's look at the structure of voting; that is, what is voting like? What are some of its important features or characteristics?

STUDENT: Each person gets a single vote.

TEACHER: Good. Let's explore the arguments at the same time. Why does each person get one vote? How does that help voting to fulfill its purposes?

STUDENT: People would be mad if some others got more than one vote and if people were left out, they might not go along with the decision. But people do get left out. Kids don't get to vote.

TEACHER: Good point. Sometimes there are rules about who gets to vote. People have to be of a certain age, for instance. That's another characteristic of voting. Thinking of the arguments again, why are there such rules?

STUDENT: Young kids aren't ready to vote for who's going to be president. They don't know enough about what's going on.

TEACHER (after collecting several further characteristics and explanatory arguments): Let's look at some of the pros and cons of the voting process.

STUDENTS: Voting promotes involvement in the government. People feel they are choosing fate. It makes it harder for a few to take advantage of people. But many voters do not bother to vote and those that do often are uninformed.

TEACHER (after more pros and cons): We have a great analysis here of voting. Let's see if we can round it off with some big ideas. Look back over what we've written. What insights do you come to? What big conclusions can you draw? Take a minute to think and let me know.

STUDENTS: Whether to vote depends on the situation. You wouldn't want soldiers to vote because they might vote not to fight. Voting works best when people get a lot of information and argue about it seriously beforehand. Secret ballots aren't always important, but when there's a lot at stake, they are.

TEACHER: These are good ideas. They help us to understand what voting is for and why it works the way it does. As we continue our study of government, we are going to pay special attention to voting and how it happens in different settings, in town meetings, legislatures, and other places. We'll see some of the trade-offs of different ways of voting and ways of making decisions without voting.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Voting

CONVERSATION A sample of what might be said

Purposes

- All have a say in their fate
- Majority satisfied with choices
- Tap people's collective wisdom

Model Cases

- Voting for president
- Voting for class president
- Voting where to take a class trip

Structure

- One person, one vote
- Secret ballot
- Qualifications to vote

Explanatory Argument

- Avoids accusations of privilege
- Harder to pressure people how to vote
- Helps guarantee competence

Evaluative Arguments—Pros

- People feel a part of choosing fate
- Harder for a few to take advantage
- Promotes involvement in government

Evaluative Arguments—Cons

- Inefficient in emergencies
- Voters may lack insight, expertise
- People may not bother to vote

CLOSURE

What insights? Voting is full of trade-offs. There are many pros and cons.

What connections? We vote for legislators who in turn vote for laws.

What conclusions? Many variations of voting adapt to different circumstances.

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Chapter 2

Knowledge as Design in the Content Areas

By now, you have a sense of knowledge as design and design conversations. But when is a good time to hold a design conversation and how does knowledge as design work across the content areas?

When to Have a Design Conversation

After Preliminary Study

A good time to have a design conversation is after some initial study of a topic—for example, after students have read a chapter in their textbooks, have field experience, or have heard a presentation. Then students can build on what they have learned because a design conversation serves to consolidate their knowledge and enhances their understanding by highlighting the form-fits-function relationship.

Introducing Topics

The design questions generate the richest conversation when students already know a fair amount about the topic—either because they have studied the topic or because it is familiar from everyday life. You might, however, have a design conversation to introduce a topic. You can use the design questions to map what students already know and what they do not know.

For example, for a design conversation introducing the topic of viruses, the teacher might say, "We haven't really talked or read about viruses. You just know a little about viruses from everyday experience. But let's use the design questions to pool what we know and identify what we don't know about viruses."

After the introductory design conversation, the teacher helps the students to keep track of the questions they generated and find answers to them. Toward the end of their study of viruses, the teacher may conduct another design conversation, filling out the original one more fully based on what they have learned.

The Teachable Moment

To a considerable degree, rich teaching is opportunistic. Teachers are alert to the teachable moment and seize it. Design conversations, as discussed so far, seem some distance from a single teachable moment—they take too long. However, the individual design questions can be used at any time, drawing a few responses from students to deepen their understanding of ideas.

For example, in a literature class, the teacher mentions haiku in passing. When a student asks what a haiku is, the teacher says, "Let me give you a *model case*," and does so from memory. The teacher then says, "Notice some features of a haiku's *structure*," names two or three features, then continues with the matter at hand.

Another example comes from a history class where students are focusing on the Monroe Doctrine. "Let's get clear about what a doctrine is," the teacher begins. "What's the *purpose* of a doctrine—any doctrine? That is, what's a doctrine for?" The teacher takes two or three answers, elaborates a little, and then goes on.

These brief episodes are far cries from a full design conversation, but they do help to orient students to ideas by focusing on the key questions of purpose, structure, model cases, and arguments.

Design Conversations in Several Content Areas

Knowledge as design is very flexible and works well with virtually any subject in the content areas. (For a list of topics across the curriculum, see page 14.) Several examples

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and assignments from the content areas are discussed below and illustrated in ready-to-use design conversation lesson plans (see pages 10-13).

Language Arts

Grammar and Punctuation. While it may not seem worthwhile to have extensive design conversations about topics such as grammar and punctuation, the point is that knowledge as design is not just for lofty topics; it is for any topics in which the students need more understanding.

Moreover, a design conversation puts the rules of grammar in a meaningful, functional context. It connects the rules to their purposes. For example, most grammar textbooks fail to talk about the communicative function or convenience of pronouns or that the reason for wanting agreement with antecedents is to allow the reader more easily to determine the antecedent. The issue of gender sensitivity is usually not raised at all.

Yet grammar is, of course, quite functional. It is full of purpose, and the rules are far from arbitrary. They abet the enterprise of good communication and help make our messages to one another clearer. No wonder students find grammar and punctuation boring when texts present it as a set of rules without functional purpose (see punctuation lesson plan, page 10).

Composition. So far, the classroom has been the setting for working through the design questions. Students are quite capable, however, of using the design questions on paper at home after they have been introduced to the basic pattern in the classroom.

Essay assignments can address any reasonably accessible topic. You can photocopy the design conversation worksheet (see page 33) and try the assignment in the box that follows or create your own.

***Television News.** Some critics say news shows focus too much on entertaining viewers and do not focus enough on the news. Watch at least one news show. Observe its structure. What is shown and for how long? Fill out the design conversation worksheet to get your ideas in order. Then, write an essay, no more than two pages long, with your pro and con arguments. Provide evidence from what you observed: Is the show delivering the news or not?*

Literature. Knowledge as design provides an excellent basis for literary analysis. Characterization, plot structure, imagery, symbolism, theme, prose styles—these are a few of the complex topics that become much clearer after a design conversation. For example, a discussion of narrative hooks might revolve around Charles Dickens' novel, *A Tale of Two Cities.* The novel begins, "It was the best of times, it was the worst of times." Comparing this with other narrative hooks as model cases and conducting a design conversation around the purposes, structure, and arguments can give students insight into the craft of the writer.

Mathematics

When teaching mathematics, it is easy to become so wrapped up in the routines of mathematics that the students do not necessarily know why they are doing the problems. The purpose gets lost. For example, the students could learn to do division without understanding that the structure of the division algorithm is based on the place value of the numbers. With a design conversation, you ensure that the students understand the key concepts and tools of the discipline. The protractor, for example, provides for an excellent design conversation (see lesson plan, page 11).

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Science

Information in the science books is often supportive of a design conversation. Biology, for example, provides a straightforward opportunity for design conversations because biological systems are functional; they help organisms to survive and reproduce.

Biology texts often make such points, so the design conversation adds richness. For instance, it is quite possible to think of purposes of features or structure that are not mentioned in the textbook. Take the purposes of the nose, for instance. Although a typical text discusses the obvious functions—cleans air by catching dust with cilia, moistens and warms air to protect the lung tissues—a design conversation often yields less obvious—yet fundamental—functions, such as eating and breathing at the same time.

More important, the design conversation adds critical and creative thinking. Biology texts, and science books in general, tend not to delve into pros and cons. Noses, for instance, are hosts for colds and subject to frostbite. Texts often fail to address such tradeoffs in biological functioning, yet these tradeoffs have great practical meaning (see respiratory system lesson plan, page 12).

In general, scientific instruments and measuring devices are a natural focus for design conversations. Consider such topics as magnifying glasses, telescopes, microscopes, litmus paper, meter sticks, and grams weights. Simple objects that incorporate scientific principles can make excellent design conversations (see thumbtack lesson, page 20). Classification systems, such as the periodic table or the taxonomy of plants and animals, also lend themselves to design conversations, as do scientific theories (see Newton's law lesson plan, page 21).

Social Studies

Social studies lessons can easily degenerate into memorization and regurgitation of events, dates, names, and other facts without much thought or analysis on the part of the students. To avoid this dry approach, try a design conversation to encourage the students to look more holistically and insightfully at historical events and documents (see Preamble lesson plan, page 13). For another example, try the assignment in the box below.

Editorials. Look at you daily newspaper at home. Find the editorial page and read the editorials as model cases. Next, try to answer the other design questions about editorials. What does their purpose seem to be? How are they structured? What are the arguments? Use the design conversation worksheet to write up your answers.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Language Arts—Punctuation

CONVERSATION A sample of what might be said

Purposes

Shows sentence type (question, etc.)

Marks pauses

Marks ends of phrases, sentences

Model Cases

. , ; : ' " ! ?

Structure

Compact

Mostly of dots and short lines

Explanatory Argument

Doesn't get in the way of the text

Quick to write; can't confuse with letters

Evaluative Arguments—Pros

Makes text much easier to read

Evaluative Arguments—Cons

Need to know the rules

CLOSURE

What insights? Punctuation boosts the readability of written materials a lot.

What connections? Punctuation stands in for oral phrasing.

What conclusions? Good use of punctuation enhances communication.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Mathematics—The Protractor

CONVERSATION A sample of what might be said

Purposes

Makes and measures angles

Easy to measure important angles—45°, 90°

Draw circles and curved lines

Measure distance with ruler on bottom

Model Cases

Show examples of several different types of protractors. Point out that they are not necessarily exactly the same.

Structure

Plastic half circle, small hole in center, a ruler on the bottom; 180°, each 10° marked both directions, 90° stands out; often transparent

Explanatory Argument

Hole allows for precision

Easy to measure angle from either end

Transparency makes it easier to see angle

Evaluative Arguments—Pros

Small, light; easy to use and carry

All work the same

Inexpensive

Evaluative Arguments—Cons

Plastic ones break easily

Slips, so easy to make mistakes

Ruler is too short

CLOSURE

What insights? Protractors may be different sizes, but one degree represents the same angle.

What connections?

What conclusions? Well-designed tools can help us to understand and do math.

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DESIGN CONVERSATION LESSON PLAN WORKSHEET

CHOICE

Topic: Science—The Respiratory System: The Nose

CONVERSATION A sample of what might be said

Purposes

Filter dust

Heat air in cold weather

Moisten air to keep lungs moist

Allows eating and breathing simultaneously

Model Cases

Nose diagram in textbook

Structure

Nostrils

Cilia (hairs)

Membranes

Explanatory Argument

Entry for air

Filter dust

Heat, moisten air

Evaluative Arguments—Pros

Does its job fairly well in general

Evaluative Arguments—Cons

Catches colds

Protrudes, so can freeze, be injured

CLOSURE

What insights? The nose is more than a simple air passage.

What connections? Parts of the body often have multiple functions.

What conclusions? Trade-offs in biological functioning.

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DESIGN CONVERSATION LESSON PLAN WORKSHEET

CHOICE

Topic: Social Studies—Preamble to the Constitution

CONVERSATION A sample of what might be said

Purposes

An introduction, an outline

What the Constitution stands for

Country's name

Unity message

Model Cases

Read Preamble in social studies text

Structure

Big "We" at the beginning

List of goals

Erudite vocabulary

Explanatory Argument

Sense of unity

Tells the reader what to expect; easy to read

Conveys seriousness

Evaluative Arguments—Pros

Evaluative Arguments—Cons

CLOSURE

What insights? Carefully crafted; no one wrote this up in three minutes.

What connections?

What conclusions? Good propaganda because the nation was not unified.

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TOPICS ACROSS THE CURRICULUM						
Art	**Social Studies**	**Language Arts**	**Math**	**Music**	**Science**	**Sports**
Animation	Apartheid	Allegory	Abacus	Cadence	Adaptation	Attire: catcher's mitt, track shoes, headband, sweat suit, shin guards
Apprenticeship	Authority	Book jacket	Axioms	Categories of music: national anthems, love songs, hymns, school songs	Aquarium	Coaching
Architecture: Parthenon, Lincoln Memorial	Capitalism	Card catalog	Base ten	Harmony	Atomic theory: Greek concept or contemporary	Combat sports: boxing, wrestling, karate, judo
Artists: Rembrandt, Picasso	Citizenship	Climax	Cartesian coordinate system	Key signature	Batteries	Equipment
Artistic revolution	Colonialism	Comic books	Decimals	Major scale	Camouflage	Exercise: jumping jacks, pushups, sit-ups, aerobic running, aerobic dancing
Color	Constitution	Diaries	Formal proofs	Measures	Chemical element	Olympics
Composition	Branches of government	Elegy	Fractions	Melody	Circulatory system	Positions
Conceptual art	Forms of government: democracy, communism, socialism, monarchy	Fable	Integers	Minor scale	Ecology	Referee
Creativity	Glasnost	Fairy tales	Linear equation	Musical instruments	Experimental method	Rules
Expression	Human rights	Grammar	Math operations: addition, subtraction, multiplication, division	Polyphony	F = ma	Sportsmanship
Galleries	Immigration laws	Hero/heroine	Metric system	Practice strategies	Feathers	Stadium
Icons	International law	Library	Negative numbers	Quarter note	Food chain	Steroids
Medium: charcoal, water colors, oils, acrylics, collage	Jails	Literary forms: Villanelle, sonnet, haiku, epic, epistolary, essay, novel	Number line	Rests	Heart as a pump	Team sports
Photography	Japanese tea ceremony	Metaphor	Percents	Music with a function: *The Star Spangled Banner, Auld Lang Syne, The Wedding March, Pomp and Circumstance*	Kepler's laws	Track events
Modern art	Labor union	Narrative hooks	Power notation	Style: jazz, pop, rock and roll, rhythm and blues, baroque, classical, romantic	Levers	Training
Museums	National boundaries	Paragraphs	Problem solving	Time signature	Mandible	
Particular works: *Guernica, Mona Lisa*	Political party	Plot	Protractor	Tuning an instrument	Mirrors and reflection	
Performance art	Responsibility	Punctuation	Pythagorean theorem	Form: rondo, sonata, fugue	Newton's laws of motion	
Perspective	Revolution	Rhythm	Quadratic equation		Periodic table	
Style: Impressionism, expressionism, abstract expressionism, super realism, pop art, schlock art	Slavery	Topic sentences	Squares		Pulleys	
	Statue of Liberty	Tragedy	Square roots		Resisters	
	Taxes	Villain	Theorems		Scientific instruments: magnifying glass, microscope, telescope, thermometer, barometer, electron microscope	
	Underground railway		Units of measure			
	United Nations		Zero			

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Chapter 3

Expanding Your Choice of Topics

The whole idea of form fits function tends to draw us toward concrete topics. Science, naturally, provides many physical topics. So does English, with something concrete and object-like such as a poem or a sentence that functions as a narrative hook, or social studies, with topics such as the Preamble to the Constitution. Thus, it is easy to miss some of the richest opportunities for a design discussion—concepts, ideas, and abstractions.

Consider, for example, a specific concept—the concept of ignorance. Can ignorance be used as the basis of a design conversation? Does ignorance have purposes? Certainly. For example, physicians sometimes do not tell us what is wrong with us because they think we will be better off not knowing. Politicians sometimes choose to keep us ignorant for political reasons.

Indeed, knowledge as design is widely applicable beyond the thing-oriented approach (see chart, page 22).

Abstract Topics

Concepts and Ideas

The notion of using a concept or an idea as the basis of a design conversation may seem esoteric indeed. But students can handle discussions at the abstract level if you pick a special case or anchor the discussion in a particular context if confusion seems likely. For instance, discuss the idea of liberty in our everyday lives (see lesson plan, page 18).

Customs, Manners, Rituals

Other abstract topics that make good design conversations are customs, manners, and rituals. Consider, for example, the handshake. Handshaking has a number of purposes—for instance, greeting someone, saying good-bye, sealing a bargain, congratulating someone. And of course it has a structure. The way we shake hands varies with the occasion. Different cultures fulfill some of the functions of shaking hands in entirely different ways, for instance by bowing in Japan (see lesson plan, page 19).

Laws, Policies, and Rules

Laws, policies, and rules have definite purposes and structures. Composed by people to keep order and lend direction to groups of people and enterprises, laws are among the most powerful abstract inventions of civilization, for example the Bill of Rights—a set of governing principles that establishes a number of freedoms for the citizens of the United States of America (see lesson plan, page 30).

Conventions and Standards

In the same spirit as laws and policies, conventions and standards help to keep human conduct orderly, safe, and efficient—for example, the convention of driving on the right side of the road.

Procedures and Processes

Standardized procedures and processes also have distinct form-fits-function designs. They were invented and often reflect considerable human ingenuity. Consider, for instance, the several procedures for voting and for keeping your votes a secret (see lesson plan, page 6).

Theories, Theorems, and Scientific Laws

Much of the wisdom of science and mathematics ends up synthesized in theories, theorems, and scientific laws in the physical and social sciences. For example, consider the purpose of Newton's famous law, F = ma (see lesson plan, page 21). It states the relationship between force, mass, and acceleration and, thereby, allows computation of any one given the other two. It also allows further algebraic manipulations to solve problems.

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Microcosms

A *microcosm*, in the design conversation sense, is any specific case that because of its richness echoes many larger themes.

The ordinary thumbtack provides an excellent example of a microcosm of basic physics. The point is a wedge and, moreover, works on a pressure principle—force applied to a very small area. The head of the tack also works on a pressure principle, distributing the same force over a very wide area so that you do not hurt your thumb. The wide head allows prying the tack out, an application of leverage. The tack's symmetry results in equal distribution of forces and helps the tack to enter straight (see lesson plan, page 20).

Design Families

Topics with many subcategories are *design families*. The topics within a design family share some broad common purposes but also have some differences in exact purpose and structure. Consider, for example, kinds of government. Subcategories include democracy, monarchy, socialism, and communism.

How do you handle design families? Choose two or three of the family members for individual discussion, have separate design conversations about each family member, then compare and contrast.

You might choose to create a comparison table. For instance, list different kinds of government across the top and the four design questions on the side. Then ask your students to describe the purposes, structure, model cases, and arguments regarding these forms of government (see diagram below).

Handling Challenging Topics

Unfamiliar Topics

With unfamiliar topics, provide background information first. For example, students can read a chapter on the respiratory system. Afterwards, you can use design discussions to synthesize and consolidate what they have studied.

DESIGN FAMILY: GOVERNMENT

TOPICS	DEMOCRACY	MONARCHY	SOCIALISM	COMMUNISM
PURPOSES	Governance by the people	Governance by hereditary authority	Governance that tries to ensure all citizens' access to key services and resources	Governance that tries to dissolve the supposed ills of private enterprise
STRUCTURE	People govern directly Representative government; elect legislative representatives, congress, parliament	In pure form, absolute power only responsible to deity; position typically inherited by eldest son	Government ownership and control of means of producing and distributing goods and services Political power in hands of community	Elimination of private property; government control of economy; wealth supposedly shared by all Authoritarian government
MODEL CASES	United States of America Ancient Greece	Limited monarchy in England Norway, Denmark, Sweden, Monaco	Former Yugoslavia	Former Soviet Union China
ARGUMENTS	+ Human rights + People's voices heard - Can be inefficient	+ Clear pattern of authority - Heriditary leader may be ineffective - Can infringe on human rights	+ Attends to people's well- being - High taxes - Bureaucratic inefficiency	+ Clear pattern of authority - Abuse of authority - People not motivated to be productive

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You may instead want to shift to a related topic about which your students know more. For instance, people are more familiar with their noses than with their bronchi, and the students probably have a lot to say about the respiratory function of the nose.

Ordinary Topics

Some topics appear too mundane for a design conversation. But remember, design conversations do not have to be long, and design conversations usually make dull topics more interesting.

By expanding the conversation to a larger category, you may add more interest. For example, instead of having a design conversation about the comma, you could have one about punctuation; the more encompassing category brings with it more richness (see lesson plan, page 10).

Technical Topics

When dealing with technical topics, it is often easier to focus on outer structure—the user's perspective—rather than internal mechanism. For example, rather than analyzing the internal engineering of a digital watch, examine the outer design: What does a digital watch look like? How do you set the time? What else does it do?

If the topic still seems too abstract for the students, switch to a more accessible topic that will serve your instructional agenda just as well—for instance, old-fashioned spring-driven watches instead of digital watches.

Challenging Purpose Questions

Sometimes, a topic does not have an obvious purpose. For example, what is the purpose or function of a thunderstorm? At first thought, nothing; thunderstorms appear to be simply meteorological phenomena.

But you can still have a rich design conversation around a topic without an obvious purpose. View it in a human context—ask what its purpose or function is in human life and society. For instance, thunderstorms provide rain, refresh the atmosphere after a hot day, and help with nitrogen fixation.

If the students are having difficulty, you might decide to choose a related topic that unequivocally has a purpose. Instead of doing a design conversation on thunderstorms, choose lighting rods, for example.

Challenging Structure Questions

Do not avoid challenging structure questions. Remember, structure means features or properties *of any sort*, not just physical. For instance, features of anger include that it is an emotion; it is strongly felt; it usually involves aggressive action; adrenaline flows; other feelings are blocked out.

If you are dealing with something a little abstract and your students seem uncertain about what would count as structure, remind them that any feature or characteristic is part of structure and help them out with a couple of ideas.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Concept—Liberty in our everyday lives

CONVERSATION A sample of what might be said

Purposes

Individual's freedom to make choices

No unreasonable societal limitations on how one thinks, speaks, acts

Model Cases

Bill of Rights

Structure

Political: vote, voice in government

Economic: own property, free enterprise

Social: free press

Explanatory Argument

Freedom to choose society's direction

Freedom to acquire wealth

Freedom of information

Evaluative Arguments—Pros

Absolute freedom (except where infringes upon another's rights)

All must meet certain responsibilities:

jury duty, voting

Evaluative Arguments—Cons

Government may have to restrict absolute freedom (traffic regulations, etc.)

CLOSURE

What insights? Freedom has responsibilities.

What connections? Bill of Rights outlines guarantee of liberty in the U.S.

What conclusions? Liberty is not complete; one person's liberty can infringe upon another's.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Custom—Shaking Hands

CONVERSATION A sample of what might be said

Purposes

Signal friendship, solidarity

Say hello, good-bye

Seal a bargain

Model Cases

Students shake hands with one another and observe details of gesture.

Analog: high five; bowing in Japan

Structure

Hands firmly clasped

Right hands

Hands have to be empty

Act of shaking

Explanatory Argument

Mutual touching is personal, intimate

Right symbolizes "good" (unfairly)

No weapons signals no aggression

Prolongs touch; makes more empathetic

Evaluative Arguments—Pros

Simple, quickly done

Evaluative Arguments—Cons

May spread disease through touch

CLOSURE

What insights? Shaking hands is based on and conveys many subtle meanings.

What connections? Many variations on shaking hands: secret handshakes, bowing.

What conclusions? Shaking hands and similar gestures play a key role in culture.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Microcosm—Basic Machines: Thumbtack as Wedge

CONVERSATION A sample of what might be said

Purposes

Thumbtacks are used to hang items on the wall and to secure and fasten a variety of items

Model Cases

Tacks, push pins

Look at the bulletin board

Distribute tacks for students to examine

Structure

Basic machine: the wedge

Head usually flat, 3/8" approximately, with a wedge-shaped point

Explanatory Argument

The point is a wedge and also works on the pressure principle, distributing a force over a small area. The head also works on the pressure principle, with a wide area.

Evaluative Arguments—Pros

Symmetry: equal distribution of forces helps tack enter straight

Wide head: provides leverage to pry tack and so won't hurt thumb

Evaluative Arguments—Cons

Shaft can bend

Hard to remove with fingernail

CLOSURE

What insights? Many simple objects involve physics.

What connections? Compare thumbtack to screw, staple, and nail.

What conclusions? We are all "intuitive physicists" in the ways we deal with ordinary objects.

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Scientific Laws—Newton's F = ma

CONVERSATION A sample of what might be said

Purposes

Explain relationship between force, mass, and acceleration for a free body

Model Cases

Lab demonstration, e.g., pucks sustained by air cushion

Everyday life, e.g., pushing a heavy versus a light person on a swing

Structure

Equation: easier to see logic if we rewrite it as a = F/m

Explanatory Argument

The more force (numerator), the more acceleration results, but more mass (denominator) gives more resistance to acceleration.

Evaluative Arguments—Pros

Gives clear mathematical relationship

Can be manipulated algebraically to solve problems

Evaluative Arguments—Cons

Friction, rotational motion complicate the picture

CLOSURE

What insights? General pattern of law (as rewritten): result = force/resistance.

What connections? Same pattern in other laws, e.g., Ohm's law: I = E/R.

What conclusions? Patterns recur throughout physics, such as inverse square relationships.

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EXPANDING YOUR TOPIC CHOICES						
Concepts and Ideas	**Customs, Manners, and Rituals**	**Laws, Policies, and Rules**	**Conventions and Standards**	**Procedures and Processes**	**Theories and Scientific Laws**	**Microcosms**
Art	Birthday customs	Busing legislation	Fraction notation	Checking out books	Pythagorean theorem	"Rhyme of the Ancient Mariner" for poetic devices: rhyme, rhythm, metaphor
Civilization	Coming-of-age rituals	Declarations of war	Let phone ring 8 times	Doing an experiment	$E=mc^2$	Australian plants and animals for ecology
Competition	Excusing oneself	Farm subsidies	Letter grades	Long division	Supply and demand	Civil War era political (not military) history for politics
Family	Inauguration rituals	Freedom of the press	Metric system	Paying at a store	Boyle's law	Impressionism as an example of a revolution in artistic styles
Justice	Polite requests	The Miranda decision	"Once upon a time"	Pouring acid	Area of triangle	Fifties rock-and-roll as an example of a revolution in musical styles
Peace	Table manners	No third-term presidents	Order of alphabet	Running a race	Gresham's law	Microscope for optics
Personality	Thanksgiving customs	Rules of baseball	Sincerely yours	Saying good-bye	Distributive law	
Retirement	Toasting	Rules of chess	Sonnet form	Telephoning	Ohm's law	
Truth	Ways of thanking	Tea tax		Using a sextant	Law of gravity	

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Chapter 4

Tips for Successful Design Conversations

The basic design conversation usually serves quite well, but it is useful to know some tricks of the trade to fine-tune your design conversations to make them as rich and compelling as possible.

Make Sure Students Understand the Question

Sometimes students do not understand a question. For example, you have asked, "What are the purposes of democracy?" Or "What's the structure of voting?" The class just looks puzzled.

- Simply paraphrase the question in more colloquial language. For instance, "What are the purposes of democracy? That is, what is democracy for? What do we want from it?" Or "What's the structure of voting? That is, how is voting organized? What are its steps or features?"
- Give a sample answer or two. "What are the purposes of democracy? For instance, one purpose is to let people rule themselves. What's another purpose?" Or "What's the structure of voting? For instance, one important part of the structure of voting is secret ballots. What else can you think of?"

Help Students Answer Questions

Occasionally, students understand the question; however, they cannot seem to think of any answers. What can you do to move the lesson along?

- Offer a sample answer or two. This helps your students get started by giving them some idea of an appropriate answer.
- Give your students time to think without making them feel awkward; engage in a side activity that takes a few seconds. For instance, say, "Let me give you a second to think." Then turn sideways and just stroll slowly across the front of the room, or say, "While you're thinking, let me check something about the next assignment," and remind yourself from your notebook what you are going to assign. Chances are in a few seconds some students will have a response.
- Have your students brainstorm answers privately before responding. When you see that students are slow to answer, say, "Why not take 30 seconds to write down one or two answers in your notes. Everyone try to think of at least one answer." Then give them the 30 seconds before you call for answers.
- Have your students brainstorm in pairs. Follow the same procedure as above except let each student talk quietly with a neighbor. By bouncing ideas off one another, they often come up with richer, more varied responses.

In general, never mind whether your students might have quick answers. Let them think about their answers anyway. Students almost always come up with a rich range of responses if given a few seconds to think without the pressure of having to put their hands up right away.

Get All Students to Participate

Perhaps the session basically is going fine. Students come up with answers, and you list them on the blackboard. But you notice that most of the responses come from a third of the class—the third that is usually responsive. What can you do to engage the rest of the class?

- Use wait time. Simply wait a few seconds (count to 5 slowly) before calling on anyone. That way, students who do not respond as quickly have time to get their hands up.
- Have your students brainstorm answers

and write them down before responding. Give them about 30 seconds, even a minute. This allows the students who are shy or not so quick time to prepare answers.
- Pair off the students with neighbors and give them 30 seconds, even a minute to respond. Teamwork usually encourages even more responsiveness.

You may want to use wait time routinely for knowledge as design activities and other discussion activities as well. Wait time does more than expand student participation; it creates an atmosphere of thoughtfulness rather than one of answer-as-fast-as-you-can.

Reach for Insightful Answers

Suppose the students respond readily to the design questions, but their answers are too straightforward; they do not dig deeply enough. How do you elicit more insight and not just a list of facts?

- Simply ask for what you want. Suppose you have asked for purposes of democracy and received several straightforward responses. Now say: "We have a good list of basics here. Now let's dig deeper. Can we find any hidden purposes to democracy—less obvious purposes?"
- This revision makes the question harder, of course, so you may need to help students respond. Suggest a sample answer so they get the idea, or give them 30 seconds wait time to think of responses.

Handle Time Limits Gracefully

With a well-chosen topic, students can go on and on. They can brainstorm purposes, aspects of structure, or pros and cons endlessly. What you thought of as a 20-minute activity turns into a 55-minute activity—and it is still not done.

Of course, once you have a few answers to each design question, you could just move on, but abruptness seems to dishonor the students' thinking. You want to tap the richness of ideas around the topic, and it is hard to cut off students when they are eager. So what can you do?

- Make a graceful transition from one design question to the next. As the teacher, you often have to decide when students have spent enough time on something for a good learning experience. Warn the students, "Let's take two or three more answers to the purpose question," and then move on.
- Give students 30 seconds to write their answers individually. Then have students call them out while you list them quickly. Although you might think that giving students time to think slows things down, it often actually speeds things up because they all know what they want to say.
- Tell your students you will write down the first several answers and then take some more orally, or you can dispense with writing altogether if it is a short design conversation. (You must be prepared to summarize the gist of what students said right before the closure step.)
- Do not use all the design questions. Perhaps two of the four are most important for a particular topic, and depth with those two serves students better than exploring all four. Or, in the same spirit, touch a couple questions lightly, even answering them yourself quickly, and invest your classroom time in the other two questions.

Elicit Clear Responses

Of course unclear responses happen a lot. Commonly, students do not know exactly what they want to say or exactly how to say it. You do not want simply to brush by such a response. What do you do?

- Do not just nod and call on the next person. Yes, this action is efficient in some sense, but it lowers the expectations for clarity and undermines the culture of thoughtfulness you are trying to build.
- Ask for clarification in an uncritical way: "I didn't quite get that. Can you say a little more?"

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- Paraphrase on the student's behalf in an uncritical way: "Let me see if I have this right. Are you saying...?" Take seriously the student's response. If the student nods or says, "yes" but indicates in word or body language that your paraphrase does not capture the meaning, ask the student to help you phrase the answer better.

Work with Errors

When students give mistaken responses, this is a dilemma. On the one hand, you do not want to write a mistaken response on the blackboard and mislead other students, but on the other hand, you do not want to undermine the students' enthusiastic participation with criticism. In general, it is almost always possible to honor a well-meant response in some way.

- Extend the benefit of the doubt if the response is open to argument. Write down the response and let it go without signaling your concern.
- Honor the idea with a caveat. For instance, suppose you have asked for the structure of democracy. Someone says, "Everyone votes." You might say, "Yes, pretty much everyone—that's really important in a democracy." Write down "pretty much everyone." Then you might go on, or you might decide to pursue the response for a moment. You can ask, "Can we be more specific? Are there some exceptions—those who don't get to vote?"
- Make a quick matter-of-fact correction and honor the spirit of the student's response. For instance, on the democracy question, a student says, "People vote at age 21." You might say, "Yes, people get the vote about that time. Actually it's 18, but that's the general idea. You're showing us that people get the vote about the time we're finishing our basic education and becoming young adults." And write down 18.

Classifications are Flexible

Sometimes when you ask one of the design questions, a student's response seems to fit better a different question—a response to the purpose question sounds more like structure or arguments, or a response to the argument question sounds more like a purpose. How can you handle this situation?

- Honor the response and reclassify it at the same time. Suppose you have asked for the purposes of democracy. A student says: "voting." You might say: "Voting is very important in a democracy. Actually, it's probably more a part of the *structure* of democracy than its purpose, a part of the way democracy works. So let me start a structure list and put it there. Now let's go back to purposes."

Some responses may fit more than one design question. What do you do?

- Put the answer where it reasonably fits and tell the students what you are doing. For instance, suppose you have asked about the structure of democracy. A student says, "Democracy gives people a say in their government." You might reply, "Yes, that's basic to democracy. It could even be a *purpose* of democracy but it certainly is a part of the *structure* of democracy." And list it under structure.
- List the response in both places, remarking, "Sometimes ideas fit well in more than one place. So we just put them in both."

Deal Positively with Inattentive or Disruptive Students

Students repeat another student's response quite often. It is annoying. You feel that the student has not been paying attention, but at the same time, you do not want to embarrass the student or undermine the momentum of the group with negativity.

- Honor the contribution while identifying it as something said before. For instance,

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you might say, "Yes, that's an important idea. I think someone else mentioned it too." Look for it on the blackboard and star it to indicate it was mentioned again.

- When the phrasing is quite different, you could say, "Yes, something like that was said before. But you've put it a little differently. Let's get your way of saying it down." Then write down the new phrasing.

Now and again, a student will give a wiseguy answer to the design questions. For instance, you have asked about purposes for democracy. A student says, "To take up lots of time studying in school." The student has seen that you are being relatively uncritical in accepting responses and is testing your resolve. On the one hand, you would like to cut the student down, while on the other, you would like to maintain the flow and not let the student succeed in the disruptive effort.

- Play it cool. Grin and say, "Okay, you got it, 'take up time studying in school.'" Write the response on the blackboard like anything else and go on. Do not get impatient if there are a couple of further wiseguy responses. Just view the responses as all in fun and continue.
- Handle it as a discipline problem in your usual manner. Although the "play it cool" strategy is best if you can get away with it, what if a student is persistently troublesome and disruptive in his or her responses? Or what if a student uses foul language that you cannot just brush off and certainly cannot write on the blackboard? Teachers have many different styles of handling classroom discipline problems, so handle the situation in your normal manner.

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Chapter 5

Beyond the Basics: Other Applications

To see knowledge as design as nothing but a series of design conversations would be inflexible and a little tedious. Using creativity, however, you can vary the basic format and introduce fresh perspectives and applications that allow students to proceed from a basic design conversation to grappling with topics in more diverse ways.

Encourage Students to Ask the Design Questions

Traditionally, questions come from the teacher and the students answer, but students' critical and creative thinking skills improve if you pass the intellectual initiative to them as much as you can. One way to conduct a more student-centered class is to encourage your students to ask the design questions.

If you let students know emphatically and repeatedly that their questions are welcome, these examples are like some student questions you might hear:

- "I understand how to divide by fractions. But what's the *purpose*? When do we need to divide by fractions?"
- "I don't get the idea of a monopoly. Can anyone give me a *model case*?"
- "How bad really are monopolies? Can we look at the *arguments*, the pros and cons?"

Of course, such questions can be disconcerting. Students may ask something for which you, the other students, or even experts do not know the answer. But if you can be comfortable with this ambiguity, it is an important lesson for students to realize that not everything is known. Often, the class can think together about what reasonable answers might be.

Group Work

Up until this point, design conversations have been presented in a whole-class setting where the teacher guides the conversation from the front of the classroom, but design conversations are also applicable to group work.

Today, teachers widely recognize the benefits of collaborative learning. One important element in many collaborative learning activities is that students have a clear agenda for how to proceed. Design conversations are one way of providing such an agenda.

For example, a teacher wants to engage the students in a discussion of Picasso's famous painting, *Guernica*. After providing some background about the Spanish Civil War, the teacher forms the students into groups of four, instructs them to choose a recorder and to go through the design questions one by one, brainstorming answers in their group to report to the rest of the class later.

When students are working with the design questions in small groups, it is convenient to have the design questions visible. Make a large wall poster that states the four design questions. Not only does a poster aid in group work, but it also makes design conversations that you conduct easier because you can point to the poster as a reminder and encourage students to initiate use of the design questions. You can also distribute copies of the design conversation worksheet (see page 33).

Written Assignments

The classroom has been the setting for working through most of the examples so far although some homework assignments have been suggested. Students are quite capable of working on paper at home after they have been introduced to the basic pattern in the classroom.

Written assignments can address any topic reasonably accessible. You can photocopy

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the design conversation worksheet (see page 33) and try one of the following assignments or create your own.

Science—Joint Function. Read the section in your science textbook on the joints of the body. Pick one kind of joint—ball joint, hinge joint, whatever you want—and answer the design questions on the worksheet.

Social Studies—Television News. Some critics say news shows focus too much on entertaining viewers and do not focus enough on the news. Watch at least one news show. Observe its structure—what is shown, for how long? Now write an essay no more than two pages long with your pro and con arguments. Provide evidence from what you observed: is the show delivering the news or not?

Problem-solving Strategies

The design questions work well as a problem-solving strategy and as a planning guide. For example, a teacher might engage the students in a design conversation when planning a class excursion, as illustrated below for "planning a field trip."

Follow-up Activities

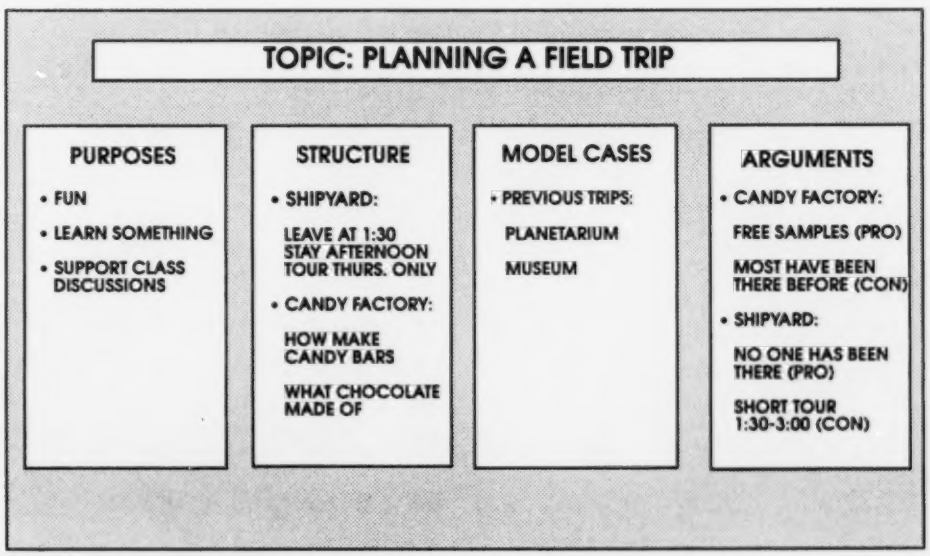
A design conversation serves well to explore a topic and deepen students' understanding, and the closure step wraps the discussion up in a nice conceptual package. A natural extension of this process is to follow up a design conversation with another activity.

Brainstorming Improvements

One of the simplest ways to use a design conversation as a stepping stone to further activities is to add a brainstorming session about possible design improvements on the item or topic under discussion.

The protractor lesson, for example, provides an excellent opportunity to extend the basic design conversation into a brainstorming activity on improving the protractor design (see lesson plan, page 11). After conducting the design conversation, ask the students to work in pairs and brainstorm some good ideas for improving protractors: "How could we make them better? How could we help them to do their jobs more effectively?"

Possible improvements students might think of include



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- Make a folding protractor so it is easy to carry.
- Make a larger protractor with a longer ruler on the flat edge because the ruler along the bottom is too short to be useful.
- Attach a ruler to the protractor so that it swivels and you can line up on angles more easily.
- Make protractors of thicker plastic so they do not break.

Finding Actual Model Cases

One way to implement a more hands-on approach is to turn students to the world around them. Send them on a search for model cases—more examples, illustrations, analogies—of the design conversation topic. Use your own assignments or you may want to try the ideas described below.

Social Studies/English. We have been studying advertising tricks. We have looked at their purposes, structure, model cases, and arguments. This week, while watching your favorite television show, watch the commercials, too. See how many model cases of advertising tricks you can find. Identify and describe each trick.

Science. We talked about the purposes and structures of springs, including the spring constant. Let us find springs at work in the world. Look around your house for model cases. Find four different springs. Write where you found them, what they do, whether they stretch or compress, whether they seem to have a high spring constant (stiff springs) or a low one (soft springs), and why they need a high or low spring constant for the job they do.

Analyzing Writing Styles and Composing Model Cases

A design conversation on written material provides an excellent basis for an assignment where students compose an example—a model case. A design conversation can help students to understand how a particular piece of writing works—its purposes, its structure, how that structure helps to serve its purposes, and the pros and cons of writing in this style.

English. For an English assignment, you might ask students to compose an additional stanza to a poem they have read and discussed or write their own model case of any of the following

- essays
- short stories
- sonnets
- haiku
- business letters
- political campaign speeches

Science. A good science assignment is to write a hypothesis about a specific topic, for example, plant growth, saying what would count as evidence for or against the hypothesis. Other science assignments for composing model cases include

- definitions
- statements of evidence
- experimental design

Social Studies. An extension of the Bill of Rights lesson (see page 20) provides an excellent opportunity to compose a model case—write a new right to add to the Bill of Rights. Other models for history composition include

- constitutions
- manifestos
- inaugural addresses
- campaign speeches

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DESIGN CONVERSATION LESSON PLAN

CHOICE

Topic: Laws, Policies, Rules—U.S. Bill of Rights

CONVERSATION A sample of what might be said

Purposes

Describes and outlines a set of governing principles and establishes a number of freedoms for U.S. citizens.

Model Cases

Read Bill of Rights in students' text

Structure

First eight establish fundamental rights and freedoms of every person; last two forbid congress to adopt laws that would violate these rights

Explanatory Argument

Humans have inborn rights the government cannot violate

Evaluative Arguments—Pros

Has stood the test of time

Supreme court interpretation allows flexibility

Evaluative Arguments—Cons

Could say more about civil rights of groups often discriminated against

CLOSURE

What insights?

What connections? Comparison can be made to Magna Carta.

What conclusions? Flexibility within a stable framework is important to social function.

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Chapter 6

Conclusion

We have come to the end of this introduction to knowledge as design, but it is certainly not the end of ways to use the idea of design ingeniously in the classroom. Make up your own angles; feel free to follow your own muse. Knowledge as design is not meant to be a formula, but a flexible philosophy.

For more ideas about knowlege as design and related themes, such as transfer of learning, consider some of the sources listed on the following page. In particular, the book. *Knowledge as Design* offers other ways of using knowlege as design and many more examples from different subject matters.

As you continue to work with knowledge as design, keep up the pace. Try to conduct a design conversation or related activity fairly frequently. To be sure, schools are busy places with numerous agendas always pressing for attention, and knowledge as design is one more agenda alongside the others.

But in a way, it is not. Knowledge as design does not stand separately from other educational agendas, one more thing to attend to detached from the rest. Knowledge as design is synergistic with content instruction. It is a tool for helping students to understand more deeply what they are studying whether they are studying space exploration, ancient Egypt, pH, or novels. Knowledge as design is not something extra. It is a way to help you do what you, as an educator, are trying to do—teach so that students understand well and deeply.

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Related Readings

Fogarty, R., D. N. Perkins, and J. Barell. *How to Teach for Transfer.* Palatine, IL: Skylight Publishing, 1991.

One of the challenges of thoughtful learning is helping students to transfer knowledge and skills from one context to another. This teachers' guidebook focuses on achieving transfer of learning.

Perkins, D. N. *Knowledge as Design.* Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1986.

Knowledge as Design offers a more theoretical treatment of the design approach than the teachers' guidebook. It also contains many more examples across the subject matters and discusses a number of creative activities.

———. *Smart Schools: From Training Memories to Educating Minds.* New York: The Free Press, 1992.

This book focuses on approaches to thoughtful teaching and learning. Its key principle is "learning is a consequence of thinking." Even sheer memory for content knowledge gains from a thinking-oriented approach, such as knowledge as design and a number of other approaches discussed in this book. It also treats general problems of assessment, school change, and related matters.

Perkins, D. N., H. Goodrich, H. S. Tishman, and J. M. Owen. *Thinking Connections.* Menlo Park, CA: Addison-Wesley, 1993.

These materials provide a systematic approach to integrating the teaching of thinking with subject matter instruction, highlighting three thinking strategies: mental management, decision making, and a variation of knowledge as design called understanding through design.

Simon, H. A. *The Sciences of the Artificial.* Cambridge, Massachusetts: The MIT Press, 1989.

Nobel-prize winning cognitive scientist Herbert Simon examines the science of design and design factors that operate in biology and in human intelligence.

Swartz, R. J., and D. N. Perkins. *Teaching Thinking: Issues and Approaches.* Pacific Grove, CA: Critical Thinking Press & Software (formerly Midwest Publications), 1989.

This book provides a general orientation for teachers interested in teaching thinking. It treats a variety of approaches, including teaching thinking as a separate subject matter and the integration of teaching thinking within subject matter instruction (*Knowledge as Design* is an example of the latter).

Weber, R. *Forks, Phonographs, and Hot-Air Balloons: A Fieldguide to Inventive Thinking.* New York: Oxford University Press, 1992.

This book offers a fascinating overview of many everyday inventions and inventive thinking and provides a number of tips about inventive thinking.

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DESIGN CONVERSATION WORKSHEET Topic:

Purposes

Model Cases

Structure

Explanatory Argument

Evaluative Arguments—Pros

Evaluative Arguments—Cons

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DESIGN CONVERSATION LESSON PLAN WORKSHEET

CHOICE

Topic

CONVERSATION A sample of what might be said

Purposes

Model Cases

Structure

Explanatory Argument

Evaluative Arguments—Pros

Evaluative Arguments—Cons

CLOSURE

What insights?

What connections?

What conclusions?

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BUILDING THINKING SKILLS® books (grades K–2, 2–4, 4–7, 7–12) provide easy, inexpensive, and effective activities for introducing thinking skills into your classroom. These supplemental class-discussion activities are available at four skill levels, each focusing on analytical thinking skills necessary for success in all academic areas. Detailed lesson plans include suggested solutions.

CRITICAL THINKING (grades 7–12) Series goals include discernment in reading and listening and clarity of thought in speaking and writing. Topics include basic concepts in critical thinking, use and misuse of words and statements, propaganda and advertising techniques, logical reasoning fallacies, quantified statements, probability of truth and falsity, characteristics of arguments, and applied logic.

THE PRACTITIONER'S GUIDE TO TEACHING THINKING is a series that enables education students, classroom teachers, and school administrators to read the best in current thought and practice in teaching thinking. The series' six authors are leaders in the field of teaching thinking, respected both for their knowledge and their clear grasp of classroom issues. Series titles: **Teaching Thinking: Issues and Approaches**; **Evaluating Critical Thinking**; and **Techniques for Teaching Thinking**.

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CRITICAL THINKING ACTIVITIES FOR MATHEMATICS (grades 3–4, 5–6, 7–8, and 9–12) This four-book series presents many problems designed to develop the range of critical thinking skills needed to succeed in mathematics. Ideas are introduced clearly and with simple examples.

MATHEMATICAL REASONING through Verbal Analysis (grades 2–4 and 4–8) presents class discussion activities that help students develop the mathematical problem solving skills recommended in the NCTM standards. Multiple strategies for solution are provided for each activity.

DEVELOPING CRITICAL THINKING THROUGH SCIENCE BOOK ONE (grades 1–4) and BOOK TWO (grades 4–6) are reproducible, hands-on physical science activities designed for the "non-science" teacher who needs to teach science. They offer many important features: No science background required • Step-by-step procedures • Zero- or low-budget materials • Minimal preparation time • Hands-on student experiments • Critical thinking questioning strategies • Ready answers • Lessons that take a typical science period.

CRITICAL THINKING IN SOCIAL STUDIES

CRITICAL THINKING IN UNITED STATES HISTORY (grades 8–12) is a four-book series with coordinated teacher's guides that challenges students with opposing interpretations of historical events from the exploration of the New World through the Vietnam War era.

YOU DECIDE! Applying the Bill of Rights to Real Cases (grades 7–12) helps students understand the origins, purposes, and applications of the Bill of Rights by providing opportunities for them to review and discuss actual Supreme Court cases as if they were real judges.

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